

A1250-1

JULY 22, 1985

CHEMICAL & ENGINEERING

NEWS

Focus & Figures
Chemical
& O
Page

News of the Week

■ Indian scientists claim cyanide poisoning caused some deaths in Bhopal disaster; U.S. counterparts deny it. **Page 6**

■ First products made in space by U.S.—polystyrene beads that are uniformly 10 μ m in diameter—are being marketed by NBS. **Page 7**

■ Many scientists oppose the Administration's Strategic Defense Initiative, claiming it will speed up the arms race. **Page 7**

■ OTA memorandum urges renewal of joint U.S./U.S.S.R. space research. **Page 8**

■ Monsanto will acquire G. D. Searle for \$2.7 billion. **Page 8**

Cover: A. H. Robins research chemist synthesizes new compound showing promise as nonsedative antihistamine

Letters **4**

Concentrates

Business **9**
Government **20**
Science/Technology **23**

The Departments

New Products **16**
Meetings **57**
Newsclips **68**

Business

Bio-Response, California-based firm specializing in contract cell culture, believes its continuous mass culturing system can play a key role in moving products from laboratory to market. **Page 10**

Government

Supreme Court upholds portion of the pesticide law that calls for binding arbitration in data compensation disputes. **Page 21**

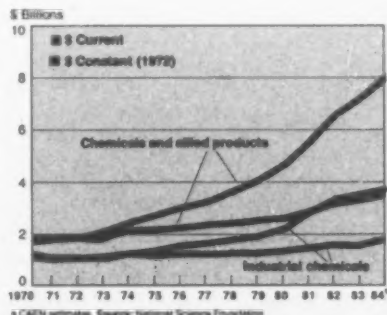
EPA does a poor job of protecting farm workers from pesticide exposure, environmental think tank reports. **Page 22**

Education

The computer age will have a profound effect on engineers of the future and the engineering curriculum must change to meet the challenges, Purdue conferees urge. **Page 24**

Technology

Catalytic reforming of methane provides a method of recovering high-temperature heat to raise the chemical energy of fuel. **Page 26**



Special Report

Total spending for R&D in the U.S. is expected to rise 11% this year, topping \$100 billion for the first time. For chemical firms, outlays also will be up 11% to more than \$8 billion. **Page 28**

Facts & Figures for Chemical R&D

1 **Overview** 30

Where R&D funds come from and who does the work. How funds are divided among basic and applied research and development

2 **Federal government** 35

R&D spending by government agencies. How federal support is divided among specific areas and types of R&D

3 **Industry** 43

How industry apportions its R&D outlays. Spending by individual chemical companies. Manpower in industrial R&D

4 **Universities and colleges** 53

Sources and uses of academic R&D funds. Largest spenders on R&D. Demographic trends

This year, for the first time, total spending for research and development in the U.S. will top \$100 billion. One of the chief reasons for the 11% growth expected in R&D spending is the substantial rise in support from the Department of Defense. In addition, the nation's healthier economy has encouraged spending. As the National Science Foundation puts it, "The 1981-82 recession and the recovery that followed solidified the belief [of many industrial executives] that, to maintain their companies' sales, profitability, and market share, it was imperative to strengthen their R&D programs."

An NSF survey finds that a third of R&D officials say their companies have boosted their R&D spending partly because of the 1981 Economic Recovery Tax Act. This act gives companies a 25% annual tax credit for increases in their R&D spending made between July 1, 1981, and Dec. 31, 1985.

The U.S. this year is expected to spend \$13.3 billion for basic research, \$22.9 billion for applied research, and \$70.4 billion for development—increases of 10%, 8%, and 12%, respectively.

The 10% advance in spending for basic research compares to increases of 11% in 1984, 10% in 1983, and only 8% in 1982. Double-digit increases for basic research in the past three years are heartening to those in the scientific community who have been urging that greater stress be placed on this area, which provides essential underpinnings for industrial growth.

The Reagan Administration's growing push for im-

proved national defense is reflected in the recent rises in Department of Defense (DOD) support of R&D. In fiscal year 1985, the department's funding of R&D is expected to climb 24% to \$34.1 billion. The department's support rose 11% in fiscal 1983 and 20% in 1984.

In fiscal 1985, DOD will account for 65% of all federal support of R&D. The other leading government funders

of R&D are the Department of Energy (9% of the total) and the Department of Health & Human Services (9%).

In 1985, industry is expected to spend \$77.5 billion in performing R&D, a gain of 12% over 1984. Of the 1985 industrial total, \$52.4 billion (68%) will come from industry's own coffers and \$25.1 billion (32%) from the government.

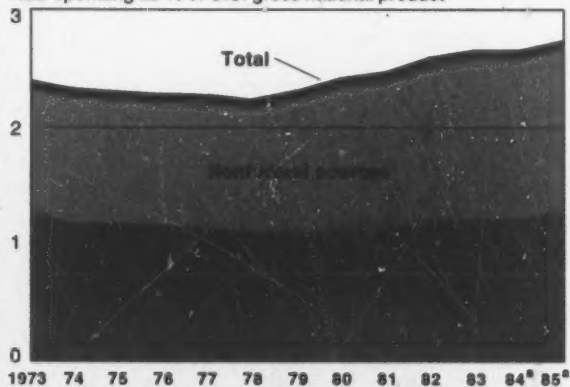
Of the \$69.3 billion spent in 1984 on industrial R&D, an estimated \$8.1 billion (12% of the total) was accounted for by the chemicals and allied products industry. R&D spending by chemical companies is being spurred not only by the nation's economic recovery but by scientific progress in such areas as biotechnology.

University R&D funds rose 12% to \$9.6 billion in 1985. This growth was made possible by increases of 12% in funding from the government, 14% from industry, 11% from academic sources, and 11% from other nonprofit institutions. Many firms are showing a greater desire to support R&D (especially basic research) on university campuses. However, two thirds of all funding for academic R&D still comes from the government.

R&D spending in the U.S. is expected to rise slightly to 2.7% of the gross national product in 1985, from 2.6% in 1982, 1983, and 1984. The recent U.S. figures are essentially the same as those of West Germany, but are greater than those of other industrialized western nations. However, when defense spending is excluded, R&D spending in the U.S. is just 1.8% of GNP, compared with 2.5% for West Germany and 2.3% for Japan. □

R&D's share of GNP continues to climb from low in 1978

R&D spending as % of U.S. gross national product



* Estimated. Source: National Science Foundation

Squibb Corp. photo

Healthy growth for R&D outlays

As inflation moderates, real spending for R&D is rising at a 7%-a-year rate, the best gain in more than 20 years

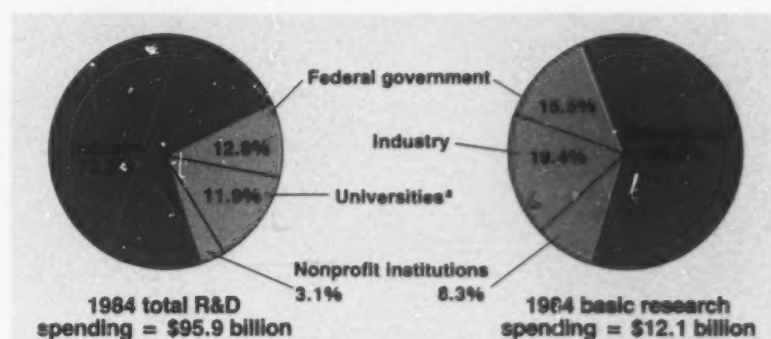
Spending for research and development in the U.S. will total \$106.6 billion this year, according to National Science Foundation estimates. Thus, for the second year in a row, if the current estimate is borne out, outlays will climb 11%.

Those are strong gains—somewhat better than 1983's 9% and 1982's 10%, certainly—but not spectacular. During the past decade, R&D spending has increased at an annual rate of nearly 12%, and during the four years before 1982 it rose at an annual rate of close to 14%.

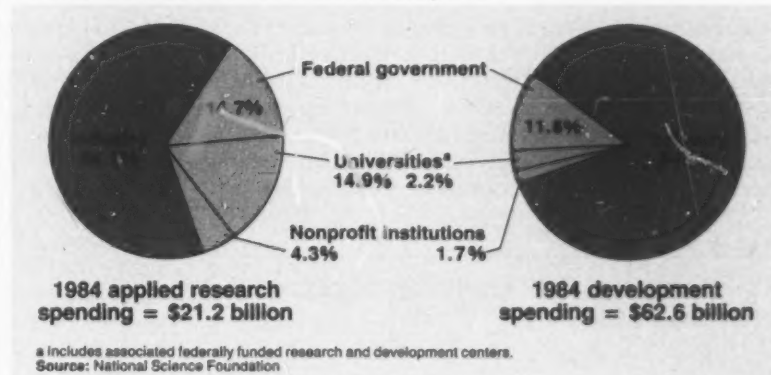
After adjustment for inflation, on the other hand, the rise in R&D outlays this year looks much more favorable. As the impact of inflation has moderated during the past two years, spending has been rising at a 7%-a-year clip, compared to growth of between 4 and 5% during the preceding half-dozen years. (Measured in constant dollars, R&D outlays actually fell in 1974 and 1975, as well as in the three-year period 1969-71.) The 7% gain for this and last year is the greatest real growth since 1964.

This year, the two major sources of R&D funds—the federal government and private industry, which together account for all but about 3% of the total—both are expected to boost financial support 11%. □

Industrial labs dominate total R&D spending, even though they handle less than a fifth of basic research . . .



. . . because they perform two thirds of applied research and all but about 15% of development



TRENDS IN R&D: Declining percentage of government-supported R&D is civilian related

% of total outlays	1985*	1984*	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968	1967	1966
Federal	47%	47%	47%	46%	46%	47%	49%	50%	50%	51%	51%	51%	53%	56%	56%	57%	58%	61%	62%	64%
Defense related	30	29	27	25	23	22	23	24	25	26	26	27	30	32	32	33	34	35	35	33
Space related	6	6	6	7	7	7	7	7	8	8	8	8	8	9	9	10	11	13	14	19
Civilian related	11	12	14	14	16	18	19	19	17	17	17	16	15	15	15	14	13	13	13	12
Nonfederal	53	53	53	54	54	53	51	50	50	49	49	49	47	44	44	43	42	39	38	36

* Estimated. Source: National Science Foundation

SOURCES OF R&D FUNDS: Industry has been biggest R&D supporter since 1980 . . .

\$ Billions, current	1985 ^a	1984 ^a	1983	1982	1981	1980	1979	1978	1977	1976	1975	Annual change	
												1984-85	1975-85
Federal government	\$49.8	\$44.7	\$40.3	\$36.5	\$33.4	\$29.5	\$26.8	\$23.9	\$21.6	\$19.9	\$18.1	11%	11%
Industry	53.2	48.0	43.2	40.1	35.9	30.9	26.1	22.5	19.6	17.7	15.8	11	13
Universities and colleges	2.3	2.1	1.8	1.7	1.5	1.3	1.2	1.0	0.9	0.8	0.7	11	13
Other nonprofit institutions	1.3	1.2	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.6	0.5	10	10
TOTAL	\$106.6	\$95.9	\$86.6	\$79.3	\$71.8	\$62.6	\$54.9	\$48.1	\$42.8	\$39.0	\$35.2	11%	12%

^a Estimated. Source: National Science Foundation

. . . but growth is uniform through all sectors this year after adjustment for inflation

\$ Billions, constant (1972)	1985 ^a	1984 ^a	1983	1982	1981	1980	1979	1978	1977	1976	1975	Annual change	
												1984-85	1975-85
Federal government	\$21.4	\$19.9	\$18.6	\$17.5	\$17.1	\$16.5	\$16.4	\$15.9	\$15.4	\$15.1	\$14.5	7%	4%
Industry	22.9	21.5	20.1	19.3	18.4	17.3	16.0	14.9	14.0	13.4	12.6	7	6
Universities and colleges	1.0	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.6	7	5
Other nonprofit institutions	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	6	4
TOTAL	\$45.9	\$42.8	\$40.1	\$38.2	\$36.7	\$35.1	\$33.6	\$32.0	\$30.5	\$29.5	\$28.2	7%	5%

^a Estimated. Source: National Science Foundation

PERFORMERS OF R&D: Almost three quarters of all R&D is done by industry, . . .

\$ Billions, current	1985 ^a	1984 ^a	1983	1982	1981	1980	1979	1978	1977	1976	1975	Annual change	
												1984-85	1975-85
Industry	\$77.5	\$69.3	\$62.8	\$58.0	\$51.8	\$44.5	\$38.2	\$33.3	\$29.8	\$27.0	\$24.2	12%	12%
Federal government	13.3	12.3	10.6	9.1	8.4	7.6	7.4	6.8	6.0	5.8	5.4	8	9
Universities and colleges	9.6	8.6	7.7	7.3	6.8	6.1	5.4	4.6	4.1	3.7	3.4	12	11
Associated FFRDCs ^b	3.0	2.8	2.7	2.5	2.5	2.2	1.9	1.7	1.4	1.1	1.0	7	12
Other nonprofit institutions	3.2	3.0	2.7	2.4	2.3	2.2	2.0	1.7	1.5	1.4	1.3	8	9
TOTAL	\$106.6	\$95.9	\$86.6	\$79.3	\$71.8	\$62.6	\$54.9	\$48.1	\$42.8	\$39.0	\$35.2	11%	12%

^a Estimated. ^b Federally funded research and development centers administered by universities and colleges. Source: National Science Foundation

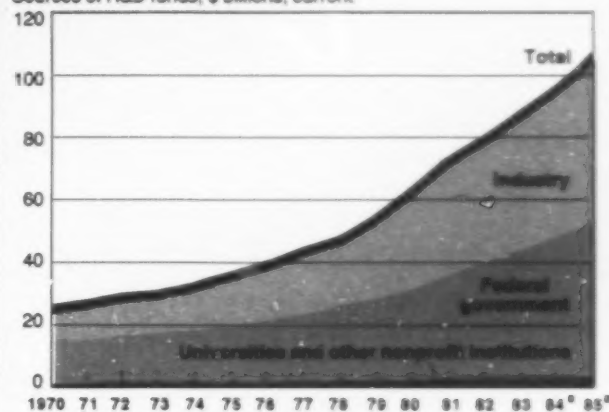
. . . which is boosting its spending, in constant dollars, 8% this year

\$ Billions, constant (1972)	1985 ^a	1984 ^a	1983	1982	1981	1980	1979	1978	1977	1976	1975	Annual change	
												1984-85	1975-85
Industry	\$33.4	\$31.0	\$29.2	\$28.0	\$26.5	\$24.9	\$23.4	\$22.1	\$21.3	\$20.4	\$19.2	8%	6%
Federal government	5.7	5.4	4.9	4.4	4.3	4.3	4.5	4.5	4.3	4.4	4.3	4	3
Universities and colleges	4.1	3.8	3.6	3.5	3.5	3.4	3.3	3.1	2.9	2.8	2.8	8	4
Associated FFRDCs ^b	1.3	1.2	1.3	1.2	1.3	1.3	1.2	1.1	1.0	0.9	0.8	4	5
Other nonprofit institutions	1.4	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.0	1.0	4	3
TOTAL	\$45.9	\$42.8	\$40.1	\$38.2	\$36.7	\$35.1	\$33.6	\$32.0	\$30.5	\$29.5	\$28.2	7%	5%

^a Estimated. ^b Federally funded research and development centers administered by universities and colleges. Source: National Science Foundation

R&D spending will top \$100 billion for first time in 1985 . . .

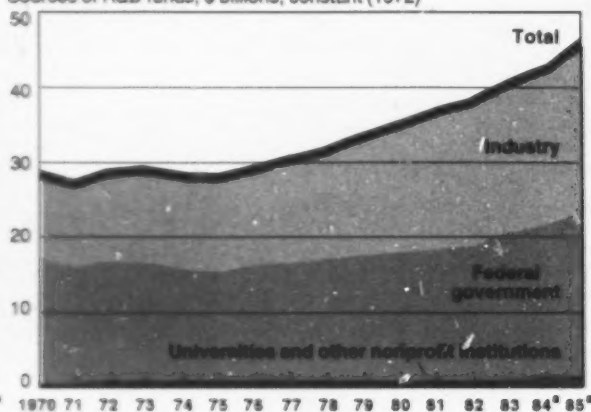
Sources of R&D funds, \$ billions, current



Estimated. Source: National Science Foundation

. . . as its growth rate continues to outstrip inflation

Sources of R&D funds, \$ billions, constant (1972)



CHARACTER OF R&D: Development is benefiting the most from increased R&D outlays . . .

\$ Billions, current	1985 ^a	1984 ^a	1983	1982	1981	1980	1979	1978	1977	1976	1975	Annual change	
												1984-85	1975-85
Basic research	\$13.9	\$12.1	\$10.9	\$ 9.9	\$ 9.2	\$ 8.1	\$ 7.3	\$ 6.4	\$ 5.5	\$ 5.0	\$ 4.6	10%	11%
Applied research	22.9	21.2	20.2	18.5	16.9	14.1	12.4	10.8	9.7	9.0	7.9	8	11
Development	70.4	62.6	55.4	50.9	45.8	40.5	35.3	30.9	27.5	25.0	22.7	12	12

^a Estimated. Source: National Science Foundation

. . . with this year's gain, in real dollars, well above its past growth rate

\$ Billions, constant (1972)	1985 ^a	1984 ^a	1983	1982	1981	1980	1979	1978	1977	1976	1975	Annual change	
												1984-85	1975-85
Basic research	\$ 5.7	\$ 5.4	\$ 5.0	\$ 4.8	\$ 4.7	\$ 4.5	\$ 4.4	\$ 4.3	\$ 3.9	\$ 3.8	\$ 3.7	6%	4%
Applied research	9.9	9.5	9.4	8.9	8.6	7.9	7.6	7.2	6.9	6.8	6.3	4	5
Development	30.3	28.0	25.7	24.5	23.4	22.7	21.6	20.5	19.6	18.9	18.1	8	5

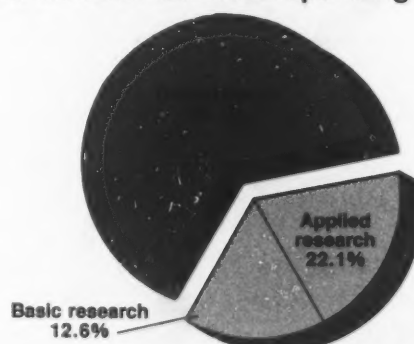
^a Estimated. Source: National Science Foundation

EMPLOYED SCIENTISTS AND ENGINEERS: Two thirds of physical scientists are chemists

	Thousands employed	Per cent
Scientists	1525.9	44.0%
Physical scientists	235.9	6.8
Chemists	158.9	4.6
Physicists/astronomers	48.4	1.4
Other physical scientists	28.6	0.8
Other scientists	1290.0	37.2
Engineers	1940.0	56.0
Chemical engineers	114.9	3.3
Other engineers	1825.1	52.7
TOTAL	3465.9	100.0%

Note: 1983 data. Source: National Science Foundation

Development accounts for almost two thirds of total R&D spending



1984 total R&D spending = \$95.9 billion

Source: National Science Foundation

ABSTRACTS OF PAPERS IN *CHEMICAL ABSTRACTS*: Biochemistry's share hits new high

% IN EACH GROUP	1984	1983	1982	1981	1980	1979	1978	1977	1976
Biochemistry	40.5%	38.3%	39.5%	39.0%	39.8%	38.8%	38.3%	37.9%	36.8%
Physical, inorganic, and analytical chemistry	28.8	29.6	28.5	28.0	28.6	28.9	27.4	27.9	27.5
Applied chemistry and chemical engineering	17.6	19.4	19.5	19.1	18.9	19.4	20.8	19.7	18.8
Organic chemistry	7.6	7.3	7.2	8.7	7.4	7.6	8.0	8.8	8.7
Macromolecular chemistry	5.5	5.4	5.3	5.2	5.3	5.3	5.5	5.7	6.2
% OF ALL BIOCHEMISTRY ABSTRACTS									
Mammalian hormones ^a	12.4%	12.9%	12.2%	6.8%	6.0%	5.9%	5.9%	5.5%	5.9%
Pharmacology	11.6	11.8	12.0	12.4	12.0	11.9	12.3	12.0	12.0
Mammalian biochemistry ^a	11.3	11.1	11.6	15.6	16.3	17.1	17.2	17.7	16.3
Toxicology	8.0	8.5	8.1	8.7	6.3	7.4	7.5	6.2	6.4
Plant biochemistry ^a	6.2	5.9	6.2	5.8	5.7	5.8	5.4	5.8	6.1
Enzymes	5.8	6.1	5.9	5.9	6.2	6.4	5.7	6.1	6.4
General biochemistry	5.3	5.8	6.0	7.5	6.6	7.0	6.5	7.0	7.1
Microbial biochemistry ^a	5.2	5.1	5.3	5.6	5.2	5.3	5.1	5.3	5.0
Others	34.2	32.8	32.7	31.7	33.7	33.2	34.4	34.4	34.8
% OF ALL PHYSICAL, INORGANIC, AND ANALYTICAL CHEMISTRY ABSTRACTS									
Nuclear chemistry	22.2%	22.5%	22.6%	21.6%	23.2%	25.1%	20.7%	21.1%	19.7%
Spectra	18.0	17.6	17.2	18.0	18.2	17.0	17.0	18.1	17.8
Electric phenomena	10.8	10.0	10.5	11.0	11.2	11.4	10.9	10.5	10.5
Crystallography and liquid crystals	7.8	8.3	8.7	8.9	8.1	8.2	9.2	8.9	9.7
General physical chemistry	6.9	7.3	7.3	7.2	7.1	6.6	6.6	6.8	7.0
Analytical chemistry	6.3	6.2	5.4	5.8	5.6	5.6	7.2	5.8	6.6
Others	28.0	28.1	28.3	27.5	26.6	25.8	28.4	28.8	28.7
% OF ALL APPLIED CHEMISTRY AND CHEMICAL ENGINEERING ABSTRACTS									
Water, wastes, and pollution	21.0%	19.6%	21.7%	24.0%	22.5%	20.8%	20.8%	23.2%	18.6%
Metals and alloys	18.9	19.1	22.2	17.9	22.0	23.6	24.0	24.2	27.8
Mineralogical and geological chemistry	14.6	14.1	13.6	14.1	15.7	15.8	16.8	13.4	17.6
Fossil fuels, derivatives, and related products	10.1	10.3	9.4	9.4	8.9	7.8	8.2	9.2	6.0
Unit operations and processes	7.0	7.5	6.9	6.4	6.0	6.1	6.4	5.8	4.8
Others	28.4	29.4	26.2	28.2	24.9	25.9	23.8	24.2	25.2
% OF ALL ORGANIC CHEMISTRY ABSTRACTS									
Physical organic chemistry	32.0%	30.5%	31.5%	37.0%	38.8%	38.8%	36.8%	41.3%	38.4%
Organometallic and organometalloidal compounds ^a	17.1	16.3	14.8	8.3	8.2	8.5	8.9	8.5	8.7
Heterocyclic compounds ^a	15.6	16.2	15.6	18.2	17.3	16.0	17.5	17.0	17.4
Aromatic compounds ^a	6.3	7.1	7.2	8.7	7.8	8.2	8.6	8.5	8.0
Carbohydrates	5.7	5.8	5.8	5.4	5.7	6.0	5.2	4.6	5.1
Amino acids, peptides, and proteins ^a	4.8	4.5	4.4	4.2	3.7	4.1	4.0	3.7	4.3
Biomolecules and their synthetic analogs ^b	4.4	4.5	3.7	—	—	—	—	—	—
Aliphatic compounds ^a	3.6	4.3	5.2	6.6	6.0	6.0	6.9	5.9	6.5
Others	10.5	10.8	11.8	11.6	12.5	12.4	12.1	10.5	11.6
% OF ALL MACROMOLECULAR CHEMISTRY ABSTRACTS									
Synthetic high polymers	34.0%	34.4%	34.7%	30.3%	27.0%	26.3%	25.6%	26.5%	28.3%
Plastics manufacture and uses	24.2	24.4	21.9	26.4	28.1	27.8	28.1	27.5	26.8
Cellulose, lignin, paper, and other wood products	9.6	9.1	9.7	10.1	10.9	11.1	10.6	10.0	9.1
Coatings, inks, and related products	7.8	6.6	7.6	7.5	7.4	8.1	7.5	7.5	7.6
Textiles	7.3	7.9	8.9	9.9	10.1	10.1	12.1	11.0	11.1
Synthetic elastomers and natural rubber	7.3	7.5	7.8	7.9	8.4	7.6	8.0	8.5	8.8
Others	9.8	10.1	9.4	7.9	8.1	9.0	8.1	9.0	8.5

^a Definition of section content changed in 1982. ^b New section in 1982. Source: Chemical Abstracts Service

U.S. PATENTS: Total increases, as does percentage granted to foreign residents

	1984	1983	1982	1981	1980	1979 ^a	1978	1977	1976	1975	1974
U.S.^b	38,364	32,872	33,896	37,356	37,152	30,605	40,979	41,383	44,162	46,603	50,643
Foreign^c	28,837	23,990	23,993	24,463	24,675	18,248	25,123	23,886	26,074	25,291	25,632
TOTAL	67,201	56,862	57,889	61,819	61,827	48,853	66,102	65,269	70,236	71,994	76,275
% Foreign	42.9%	42.2%	41.4%	39.6%	39.9%	37.4%	38.0%	36.6%	37.1%	35.3%	33.6%

^a Patent figures were low in 1979 because the U.S. Patent & Trademark Office was short of funds to print patents it might otherwise have issued. ^b U.S. patents granted to U.S. residents.

^c U.S. patents granted to residents of foreign countries. Source: U.S. Patent & Trademark Office

Most of the growth focuses on defense

FEDERAL OBLIGATIONS FOR R&D: Spending for defense has doubled since 1981

Department or agency	Total R&D (\$ millions)				
	1985 ^a	1984 ^a	1983	1982	1981
Agriculture	\$ 898.9	\$ 871.8	\$ 847.6	\$ 797.3	\$ 774.0
Agricultural Research Service	466.9	452.9	443.4	404.9	394.1
Cooperative State Research Service	256.8	237.7	232.3	219.0	199.4
Commerce	270.6	360.0	335.0	336.3	328.0
National Bureau of Standards	91.2	96.0	95.0	88.8	82.5
National Oceanic & Atmospheric Administration	165.2	244.3	222.0	222.0	201.4
Defense	34,142.1	27,540.0	22,992.8	20,622.6	16,508.6
Air Force	14,700.7	12,756.4	10,812.6	9,357.9	6,969.2
Army	5,153.8	4,475.5	3,998.1	3,760.5	3,244.2
Navy	9,715.4	7,526.0	6,068.2	5,845.1	5,006.0
Defense agencies ^b	4,513.4	2,729.5	2,052.3	1,618.1	1,248.2
Energy	4,962.3	4,825.6	4,536.7	4,708.2	4,918.2
Environmental Protection Agency	280.9	250.0	240.7	335.1	235.7
Health & Human Services	4,954.0	4,864.3	4,352.5	3,940.7	3,927.1
National Institutes of Health	4,345.4	4,240.2	3,789.2	3,433.1	3,333.2
Interior	369.0	421.8	382.5	381.1	427.1
National Aeronautics & Space Administration	3,339.4	2,888.9	2,661.6	3,077.9	5,406.6
National Science Foundation	1,414.0	1,238.5	1,062.0	975.3	961.6
Tennessee Valley Authority	80.7	73.3	63.0	85.0	68.9
Others	1,541.7	1,501.5	1,237.1	1,173.1	1,271.6
TOTAL	\$52,253.6	\$44,835.8	\$38,711.5	\$36,432.6	\$34,917.4

^a Estimated. ^b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. Note: Fiscal years. Source: National Science Foundation

FEDERAL OBLIGATIONS FOR RESEARCH: Bigger gains for basic than for applied research

Department or agency, \$ millions	1985 ^a		1984 ^a		1983		1982		1981	
	Basic research	Applied research	Basic research	Applied research	Basic research	Applied research	Basic research	Applied research	Basic research	Applied research
Agriculture	\$ 419.7	\$ 450.0	\$ 386.4	\$ 455.6	\$ 362.0	\$ 455.5	\$ 330.8	\$ 435.7	\$ 314.1	\$ 426.9
Agricultural Research Service	240.1	201.2	232.5	194.9	215.3	192.9	186.2	186.4	186.4	181.5
Cooperative State Research Service	128.6	128.2	100.8	136.8	98.8	133.5	91.3	127.7	83.9	115.5
Commerce	18.4	201.2	20.5	272.6	19.2	265.6	16.9	259.2	16.2	233.2
National Bureau of Standards	17.8	63.7	19.2	63.1	18.4	63.1	16.5	57.4	15.6	50.6
National Oceanic & Atmospheric Administration	0	127.2	0	194.6	0	188.9	0	188.5	0	168.5
Defense	913.2	2406.2	816.6	2168.2	785.6	2437.0	686.7	2266.1	604.3	1996.6
Air Force	206.2	577.2	187.9	514.1	164.2	524.2	145.8	488.1	125.8	491.5
Army	238.5	564.1	209.2	464.2	208.3	485.3	187.7	451.6	148.1	388.4
Navy	359.9	492.3	308.5	426.1	305.4	521.6	280.3	498.4	238.0	460.0
Defense agencies ^b	108.6	772.6	111.0	763.8	107.7	905.9	72.9	828.1	92.4	656.7
Energy	944.5	1269.0	841.7	1231.7	767.7	1193.4	642.2	1,053.9	586.3	827.3
Environmental Protection Agency	25.5	174.1	22.7	155.2	22.2	152.4	32.7	210.7	10.5	207.8
Health & Human Services	2925.9	1679.1	2793.1	1705.9	2475.4	1545.4	2144.7	1460.9	1900.4	1591.9
National Institutes of Health	2738.1	1264.9	2607.7	1286.3	2313.0	1165.2	2020.7	1103.8	1766.8	1181.5
Interior	102.8	248.6	124.7	276.3	103.0	254.7	76.5	275.0	80.7	289.2
National Aeronautics & Space Administration	826.7	1086.1	689.1	1012.0	617.0	927.8	535.7	871.4	531.1	876.0
National Science Foundation	1335.8	78.2	1172.5	66.0	999.1	62.9	916.1	57.1	896.6	58.9
Tennessee Valley Authority	5.6	8.4	5.0	8.0	5.6	6.7	4.6	8.1	4.8	9.4
Others	119.5	793.7	108.7	775.8	103.3	692.0	94.7	642.5	96.3	654.3
TOTAL	\$7637.6	\$8396.6	\$6981.0	\$8127.3	\$6260.1	\$7993.4	\$5461.6	\$7540.6	\$5041.3	\$7171.5

^a Estimated. ^b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. Note: Fiscal years. Source: National Science Foundation

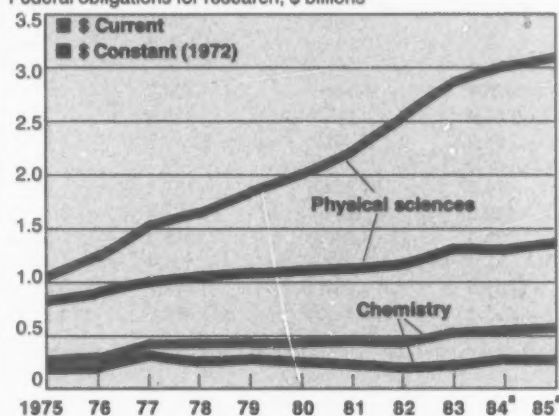
FEDERAL OBLIGATIONS FOR SCIENTIFIC DISCIPLINES: No growth for chemical funding

\$ Millions for research only	1985 ^a	1984 ^a	1983	1982	1981	Annual change	
						1984-83	1981-1985
Engineering	\$ 3,845.5	\$ 3,551.8	\$ 3,517.0	\$ 3,386.5	\$ 3,071.5	8%	6%
Chemical	143.5	143.8	145.0	95.1	147.6	0	-1
Metallurgy and materials	369.2	346.3	332.5	309.1	256.0	7	10
Environmental sciences	1,336.2	1,279.3	1,251.2	1,148.3	1,121.1	4	5
Life sciences	5,981.4	5,749.1	5,177.9	4,745.5	4,435.6	4	8
Mathematics and computer sciences	579.2	446.2	419.4	350.1	278.9	30	20
Physical sciences	3,143.1	3,002.5	2,891.4	2,500.4	2,220.5	5	9
Chemistry	595.7	571.1	520.3	481.2	436.9	4	5
Physics	1,932.9	1,868.9	1,854.6	1,610.5	1,345.6	3	9
Other sciences	1,148.8	1,079.4	996.6	891.4	1,085.2	6	1
TOTAL	\$16,034.2	\$15,106.3	\$14,253.5	\$13,022.2	\$12,212.8	6%	6%

^a Estimated. Note: Fiscal years. Source: National Science Foundation

Federal funding for physical sciences changed little after adjusting for inflation

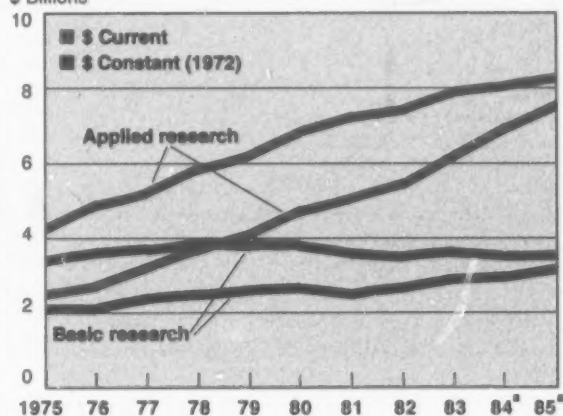
Federal obligations for research, \$ billions



^a Estimated. Note: Fiscal years. Source: National Science Foundation

Basic research is winning a bigger share of total government research funds

\$ Billions



^a Estimated. Note: Fiscal years. Source: National Science Foundation

FEDERAL OBLIGATIONS FOR DEVELOPMENT: Defense gets 85% of total funds

Department or agency	Development (\$ millions)				
	1985 ^a	1984 ^a	1983	1982	1981
Agriculture	\$ 29.2	\$ 29.9	\$ 30.0	\$ 30.6	\$ 33.0
Agricultural Research Service	25.6	25.5	25.5	25.8	26.2
Cooperative State Research Service	0	0	0	0	0
Commerce	51.0	66.9	50.2	60.2	78.6
National Bureau of Standards	9.6	13.7	13.6	14.9	16.3
National Oceanic & Atmospheric Administration	38.0	49.8	33.1	33.5	32.9
Defense	30,822.7	24,555.3	19,770.1	17,669.8	13,907.7
Air Force	13,917.3	12,054.4	10,124.2	8,724.0	6,351.9
Army	4,351.2	3,802.1	3,304.5	3,121.3	2,707.7
Navy	8,863.2	6,791.4	5,241.2	5,066.4	4,308.0
Defense agencies ^b	3,632.2	1,854.7	1,038.7	717.1	499.1
Energy	2,748.8	2,752.2	2,575.6	3,012.1	3,504.6
Environmental Protection Agency	81.3	72.1	66.1	91.7	107.4
Health & Human Services	348.9	365.3	331.7	335.2	434.9
National Institutes of Health	342.4	346.1	311.0	308.7	384.9
Interior	17.7	20.6	24.8	29.6	57.3
National Aeronautics & Space Administration	1,424.6	1,187.7	1,116.8	1,670.7	3,999.4
National Science Foundation	0	0	0	2.2	6.1
Tennessee Valley Authority	66.7	60.3	50.7	72.3	54.7
Others	628.5	617.0	442.0	435.8	520.9
TOTAL	\$36,219.4	\$29,727.5	\$24,458.0	\$23,410.4	\$22,704.6

^a Estimated. ^b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. Note: Fiscal years. Source: National Science Foundation

BASIC RESEARCH: Energy Department cuts funding for chemistry

Department or agency	Federal obligations (\$ millions)									
	1985 ^a		1984 ^a		1983		1982		1981	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	\$ 43.8	\$ 41.9	\$ 42.9	\$ 41.0	\$ 40.0	\$ 38.2	\$ 36.2	\$ 34.5	\$ 33.7	\$ 31.8
Agricultural Research Service	37.3	36.0	36.1	34.8	33.5	32.2	30.0	28.9	27.7	26.5
Cooperative State Research Service	3.9	3.9	4.2	4.2	4.1	4.1	3.8	3.8	3.4	3.4
Commerce	15.1	4.8	16.3	5.2	15.7	4.7	13.7	4.2	12.6	2.9
National Bureau of Standards	14.9	4.6	15.9	4.8	15.7	4.6	13.7	4.2	12.6	2.9
Defense	228.1	65.3	205.3	57.8	198.4	55.6	188.7	51.5	194.9	43.5
Air Force	50.3	21.2	45.9	19.9	39.3	17.5	34.2	13.9	32.3	12.9
Army	65.5	20.9	57.6	18.2	58.7	19.4	59.6	20.0	49.5	14.5
Navy	110.2	23.3	99.0	19.8	98.0	18.7	93.1	17.7	79.7	15.9
Defense agencies ^b	2.0	0	2.7	0	2.5	0	1.8	0	33.4	0.2
Energy	788.5	93.7	897.0	113.1	839.2	104.3	530.8	75.5	480.2	70.0
Environmental Protection Agency	2.3	2.0	2.1	1.8	2.3	1.5	3.8	3.5	2.9	2.9
Health & Human Services	73.8	65.9	69.3	61.7	61.8	55.0	53.2	48.0	53.2	46.0
National Institutes of Health	72.0	64.1	68.6	61.1	60.9	54.2	52.9	47.7	52.8	47.6
Interior	3.8	2.8	4.0	3.0	2.9	1.8	8.1	2.5	10.1	6.8
Geological Survey	3.8	2.8	4.0	3.0	2.6	1.8	2.6	1.9	3.0	2.0
National Aeronautics & Space Administration	416.7	18.2	359.4	8.8	329.5	7.7	280.6	5.2	268.9	6.6
National Science Foundation	388.3	118.6	339.7	103.7	283.5	88.5	266.6	83.3	254.8	81.5
Tennessee Valley Authority	4.0	4.0	3.7	3.7	3.5	3.5	3.0	3.0	3.1	3.1
Others	12.8	0.8	11.4	0.8	10.4	1.0	9.1	0.8	10.5	1.1
TOTAL	\$1958.2	\$418.0	\$1751.1	\$400.6	\$1587.2	\$362.2	\$1393.8	\$312.0	\$1324.9	\$298.2

^a Estimated. ^b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. *Note:* Fiscal years. *Source:* National Science Foundation

APPLIED RESEARCH: Defense furnishes more than 40% of federal funds for chemistry

Department or agency	Federal obligations (\$ millions)									
	1985 ^a		1984 ^a		1983		1982		1981	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	\$ 27.0	\$ 25.1	\$ 27.0	\$ 25.1	\$ 27.6	\$ 25.6	\$ 26.0	\$ 24.0	\$ 25.0	\$ 22.7
Agricultural Research Service	18.5	17.1	17.9	16.6	18.6	17.2	17.1	15.8	16.2	14.6
Cooperative State Research Service	6.4	6.4	6.8	6.8	6.7	6.7	6.4	6.4	5.8	5.8
Commerce	37.8	10.7	33.7	9.1	33.9	9.3	32.6	8.8	30.5	8.9
National Bureau of Standards	30.4	9.4	25.3	7.3	26.7	8.1	25.4	7.3	24.4	7.5
Defense	382.2	75.7	471.1	74.4	562.0	66.3	500.0	66.6	335.2	47.2
Air Force	60.5	15.1	55.0	14.0	54.5	13.7	50.5	13.3	49.7	14.3
Army	105.9	46.7	71.6	43.9	86.9	39.9	83.2	41.4	58.6	24.6
Navy	71.2	13.7	66.0	16.3	135.2	12.3	128.7	11.7	98.5	8.1
Defense agencies ^b	144.6	0.2	278.5	0.3	285.4	0.3	237.6	0.3	128.4	0.3
Energy	625.0	18.1	615.4	14.2	584.8	13.3	482.8	29.9	390.2	13.7
Environmental Protection Agency	15.8	14.5	13.7	12.6	13.9	12.6	16.6	15.3	66.4	66.4
Health & Human Services	25.3	21.6	24.6	20.9	22.6	19.2	17.6	15.3	25.1	22.1
National Institutes of Health	23.3	19.6	23.7	19.9	21.5	18.1	17.2	14.9	24.8	21.8
Interior	7.1	3.9	7.8	6.5	5.5	4.4	10.2	3.7	7.3	5.3
Geological Survey	4.8	3.8	7.0	6.0	4.7	3.8	4.0	3.2	5.0	4.0
National Aeronautics & Space Administration	46.6	2.0	43.2	1.8	40.4	1.7	8.9	1.0	11.3	1.1
National Science Foundation	12.7	4.9	10.3	4.3	9.4	3.9	6.0	2.6	2.2	0.9
Others	5.4	1.2	4.7	1.7	4.2	1.8	5.8	1.8	2.4	0.4
TOTAL	\$1184.9	\$177.7	\$1251.5	\$170.6	\$1304.3	\$158.1	\$1106.5	\$169.2	\$895.6	\$188.7

^a Estimated. ^b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. *Note:* Fiscal years. *Source:* National Science Foundation

OBLIGATIONS FOR ENGINEERING RESEARCH: Little change for chemical engineering

Department or agency	Federal obligations (\$ millions)									
	1985 ^a	1984 ^a	1983	1982	1981	1980	1979	1978	1977	1976
	Engi- neering	Chemical engi- neering	Engi- neering	Chemical engi- neering	Engi- neering	Chemical engi- neering	Engi- neering	Chemical engi- neering	Engi- neering	Chemical engi- neering
Agriculture	\$ 55.0	\$ 6.3	\$ 55.2	\$ 6.3	\$ 54.7	\$ 6.2	\$ 51.2	\$ 5.8	\$ 50.7	\$ 5.3
Agricultural Research Service	34.0	3.4	33.0	3.3	32.9	3.2	30.0	2.9	30.0	2.7
Cooperative State Research Service	7.1	0	7.6	0	7.4	0	6.9	0	6.3	0
Commerce	29.8	1.5	37.3	1.4	37.4	1.3	32.0	2.0	28.5	1.0
National Bureau of Standards	25.4	1.5	30.0	1.4	29.4	1.3	23.8	2.0	19.7	1.0
Defense	1650.9	40.1	1463.4	38.5	1573.9	44.9	1473.3	39.0	1324.1	3.1
Air Force	468.3	3.5	417.7	2.9	419.3	3.1	387.3	2.9	388.3	2.6
Army	357.6	24.1	303.5	21.7	318.9	29.3	297.2	24.4	266.0	18.3
Navy	430.1	12.4	374.8	11.8	395.5	11.9	378.0	11.6	256.4	9.9
Defense agencies ^b	394.8	0.2	367.4	0.2	440.2	0.6	410.8	0.2	313.4	0.2
Energy	479.5	45.8	439.1	54.4	440.2	51.9	420.8	1.1	270.2	30.6
Environmental Protection Agency	41.7	16.3	37.1	16.6	47.8	16.7	76.4	26.0	77.2	55.8
Health & Human Services	45.5	0	44.4	0	39.7	0	41.4	0	48.8	0
National Institutes of Health	45.4	0	44.3	0	39.7	0	41.4	0	43.6	0
Interior	78.1	0.4	119.0	0.7	91.4	0.4	87.1	1.4	68.5	3.4
Geological Survey	4.3	0	6.3	0	5.7	0	8.2	0.2	7.0	0
National Aeronautics & Space Administration	1006.3	1.3	908.6	1.1	799.6	1.0	771.7	0.4	780.7	0.3
National Science Foundation	203.6	31.0	168.6	25.7	142.5	21.5	129.9	18.8	121.0	19.1
Tennessee Valley Authority	4.6	0	4.2	0	3.2	0	5.1	0	7.6	0
Others	250.5	0.8	274.9	1.0	286.6	1.1	297.6	0.6	294.2	1.0
TOTAL	\$3845.5	\$143.5	\$3551.8	\$143.8	\$3517.0	\$145.0	\$3386.5	\$95.1	\$3071.5	\$147.6

^a Estimated. ^b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, Defense Communications Agency, and others. Note: Fiscal years. Source: National Science Foundation

UNIVERSITY RESEARCH: Biggest growth is in math and computer sciences

Federal obligations, \$ millions	1985 ^a	1984 ^a	1983	1982	1981	1980	1979	Annual change	
								1984-85	1978-85
Engineering	\$ 510.4	\$ 449.4	\$ 408.7	\$ 361.5	\$ 365.3	\$ 323.7	\$ 269.6	14%	11%
Chemical	32.7	28.4	23.6	19.4	21.9	20.3	19.2	15	9
Metallurgy and materials	115.2	96.7	86.0	75.3	69.5	57.3	52.3	19	14
Environmental sciences	361.1	325.2	316.9	274.7	280.3	297.0	275.5	11	5
Life sciences	2873.8	2757.7	2460.0	2205.0	2117.2	1984.7	1796.0	4	8
Mathematics and computer sciences	232.1	186.8	172.4	139.7	121.4	94.6	87.5	23	18
Physical sciences	748.0	684.5	596.5	559.1	525.2	461.0	402.8	9	11
Chemistry	250.5	233.2	205.7	189.6	193.5	159.5	140.1	7	10
Physics	414.7	379.0	328.8	308.0	274.5	246.1	214.7	9	12
Other sciences	332.5	327.4	297.8	255.7	297.5	302.7	285.6	2	3
TOTAL	\$5057.9	\$4733.0	\$4252.3	\$3795.7	\$3706.9	\$3463.6	\$3117.0	7%	8%

^a Estimated. Note: Fiscal years. Source: National Science Foundation

UNIVERSITY BASIC RESEARCH: Government funding of basic chemistry continues to climb

Federal obligations, \$ millions	1985 ^a	1984 ^a	1983	1982	1981	1980	1979	Annual change	
								1984-85	1978-85
Engineering	\$ 388.6	\$ 333.4	\$ 295.5	\$ 259.0	\$ 237.3	\$ 208.4	\$ 164.0	17%	15%
Chemical	27.2	22.7	18.9	16.8	19.8	16.9	12.5	20	14
Metallurgy and materials	102.8	87.4	76.8	69.6	62.6	51.9	47.6	18	14
Environmental sciences	326.2	300.5	284.3	258.0	241.9	255.3	229.9	9	6
Life sciences	2067.8	1928.9	1701.7	1483.7	1314.6	1219.5	1140.1	7	10
Mathematics and computer sciences	196.8	158.9	146.8	118.8	102.6	79.8	69.0	24	19
Physical sciences	645.3	577.2	502.2	455.3	434.7	375.9	323.3	12	12
Chemistry	224.5	204.2	181.9	165.3	164.7	136.1	114.3	10	12
Physics	347.7	307.7	264.7	238.6	222.4	194.3	166.2	13	13
Other sciences	178.4	166.9	147.2	120.5	148.2	152.4	125.4	7	6
TOTAL	\$3803.1	\$3465.8	\$3077.7	\$2693.3	\$2479.0	\$2291.3	\$2051.7	10%	11%

^a Estimated. Note: Fiscal years. Source: National Science Foundation

Industry hiked spending 10% last year

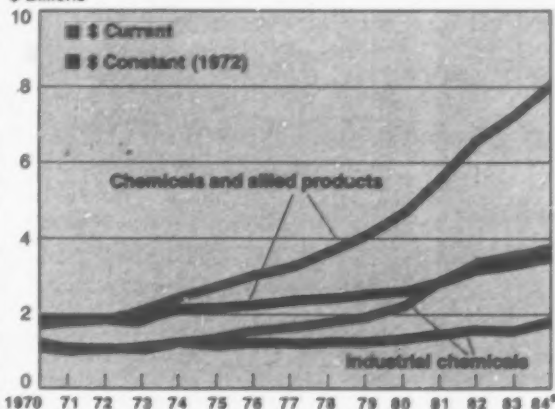
TOTAL FUNDS FOR INDUSTRIAL R&D: Chemical industry's share is nearly 12% of total

\$ Millions	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change	
												1983-84	1974-84
Chemicals and allied products	\$ 8,070*	\$ 7,287	\$ 6,859	\$ 5,825	\$ 4,836	\$ 4,038	\$ 3,580	\$ 3,202	\$ 3,017	\$ 2,727	\$ 2,450	11%	13%
Industrial chemicals	3,760*	3,409	3,301	2,802	2,197	1,962	1,798	1,668	1,524	1,391	1,299	10	11
Drugs					1,777	1,517	1,308	1,117	1,091	981	807		
Other chemicals	4,310*	3,878	3,358	2,823	662	559	474	417	401	354	344	11	14
Other industries	61,230*	55,529	51,337	46,185	39,669	34,188	29,724	26,823	23,980	21,460	20,437	10	12
TOTAL	\$89,300	\$82,616	\$79,996	\$51,810	\$44,505	\$38,226	\$33,304	\$29,825	\$26,997	\$24,187	\$22,887	10%	12%

* C&EN estimates. Source: National Science Foundation

Chemical industry's R&D outlays move higher despite inflation

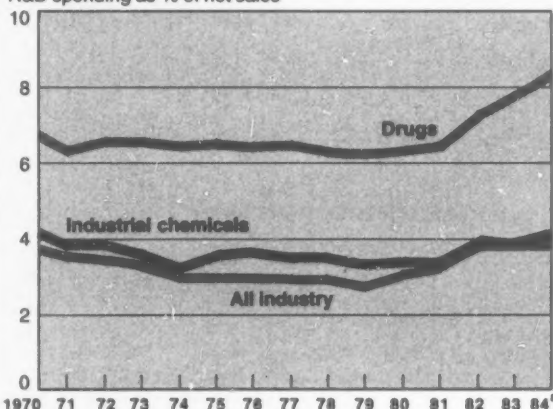
\$ Billions



* C&EN estimates. Source: National Science Foundation

Percentage for drug firms is about double that for all industry

R&D spending as % of net sales



* C&EN estimates. Source: National Science Foundation

COMPANY FUNDS FOR INDUSTRIAL R&D: Industry boosts its own R&D spending

\$ Millions	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change	
												1983-84	1974-84
Chemicals and allied products	\$ 7,600*	\$ 6,839	\$ 6,226	\$ 5,205	\$ 4,264	\$ 3,692	\$ 3,250	\$ 2,907	\$ 2,751	\$ 2,490	\$ 2,236	11%	13%
Industrial chemicals	3,300*	2,969	2,879	2,393	1,856	1,617	1,473	1,387	1,275	1,173	1,105	11	12
Drugs	3,250*	2,931	2,490	2,064	1,755	2,075	1,777	1,520	1,476	1,317	1,131	11	14
Other chemicals	1,050*	940	856	747	653							12	
Other industries	39,650*	35,761	33,286	30,223	26,212	22,016	18,865	16,433	14,685	13,092	12,431	11	12
TOTAL	\$47,250	\$42,600	\$39,512	\$35,428	\$30,476	\$25,708	\$22,115	\$19,340	\$17,436	\$15,582	\$14,667	11%	12%

* C&EN estimates. Source: National Science Foundation

FEDERAL FUNDS FOR INDUSTRIAL R&D: Chemical industry's share is slim

\$ Millions	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change	
												1983-84	1974-84
Chemicals and allied products	\$ 470 ^a	\$ 448	\$ 434	\$ 421	\$ 372	\$ 348	\$ 330	\$ 295	\$ 266	\$ 236	\$ 214	5%	8%
Industrial chemicals	460 ^a	440	423	409	341	345	325	281	249	218	194	5	9
Drugs and other chemicals	10 ^a	8	11	12	31	1	5	14	17	18	20	25	-7
Other industries	21,530 ^a	19,767	18,049	15,961	13,657	12,172	10,859	10,190	9,295	8,369	8,006	9	10
TOTAL	\$22,000	\$20,215	\$18,483	\$16,382	\$14,025	\$12,518	\$11,189	\$10,485	\$9,561	\$8,605	\$8,220	9%	10%

^a C&EN estimates. Source: National Science Foundation

R&D BY U.S. COMPANIES ABROAD: Growing faster for chemical industry than elsewhere

\$ Millions	1984 ^a	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	Annual change	
												1983-84	1974-84
Chemicals and allied products	\$ 800	\$ 733	\$ 684	\$ 715	\$ 603	\$ 500	\$ 395	\$ 332	\$ 312	\$ 269	\$ 208	9%	12%
Industrial and other chemicals	390	346	313	287	245	199	151	133	108	85	82	13	16
Drugs	410	387	371	428	357	301	244	199	204	184	126	6	8
Other industries	2600	2501	2413	2679	2562	2254	1814	1545	1347	1185	1092	4	8
TOTAL	\$3400	\$3234	\$3098	\$3393	\$3165	\$2754	\$2209	\$1877	\$1659	\$1454	\$1300	5%	11%

^a C&EN estimates. Source: National Science Foundation

CHEMICAL R&D SPENDING: Rise planned for 1985 is less than in early 1980s

\$ Millions	1985 ^a	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975
Air Products	\$ 51	\$ 44	\$ 40	\$ 37	\$ 32	\$ 30	\$ 24	\$ 23	\$ 24	\$ 19	\$ 16
American Cyanamid	250	237	215	190	172	148	130	108	96	83	73
Celanese	105	94	85	100	104	94	92	83	77	70	64
Dow Chemical	530	507	492	460	404	314	269	232	203	188	167
Du Pont^b	1100	1000	875	775	647	591	509	461	367	353	336
Ethyl	42	40	39	39	37	34	29	25	28	25	19
W. R. Grace	90	79	71	62	55	45	42	37	32	28	30
Hercules	79	72	74	74	85	57	50	43	40	37	32
Lubrizol	38	38	37	36	33	28	23	21	19	17	17
Monsanto	450	370	290	264	233	208	161	136	132	114	116
Olin	53	54	51	47	39	31	26	25	25	23	24
PPG Industries	185	150	127	127	119	103	83	70	61	56	50
Rohm & Haas	120	109	100	92	77	67	54	49	45	43	39
Stauffer Chemical^c	68	66	63	57	49	44	35	32	32	28	23
Union Carbide	260	265	245	240	207	166	161	156	156	143	120
TOTAL	\$3441	\$3125	\$2804	\$2600	\$2273	\$1960	\$1688	\$1501	\$1337	\$1227	\$1126
ANNUAL CHANGE	10%	11%	8%	14%	16%	16%	12%	12%	9%	9%	9%

^a Planned. ^b Excludes petroleum and coal segments. ^c All figures are restated for fiscal year ending Sept. 30; Stauffer Chemical was acquired by Chemagro-Pond's in first-quarter 1985. Sources: Company data and estimates

BASIC RESEARCH IN INDUSTRY: Industrial chemical firms do most of chemical industry total

\$ Millions	1983	1981	1979	1977	1976	1975	1974	1973
Chemicals and allied products	\$ 650	\$ 569	\$ 366	\$337	\$332	\$298	\$294	\$241
Industrial chemicals	350	380	190	183	168	155	130	110
Drugs	na	185	150	130	128	113	118	100
Other chemicals	na	23	26	25	36	31	46	32
Other industries	1454	1045	792	574	505	432	415	398
TOTAL	\$2104	\$1814	\$1158	\$911	\$837	\$730	\$709	\$637

Note: No data for 1978, 1980, and 1982. na = not available. Sources: National Science Foundation and C&EN estimates based on NSF data

APPLIED RESEARCH IN INDUSTRY: Four times more than basic research for chemical industry

\$ Millions	1983	1981	1979	1977	1976	1975	1974	1973
Chemicals and allied products	\$ 2,638	\$ 2,391	\$1726	\$1347	\$1219	\$1102	\$ 965	\$ 857
Industrial chemicals	1,372	1,250	853	695	593	537	565	489
Drugs	na	890	684	479	470	426	299	273
Other chemicals	na	251	189	173	156	138	101	95
Other industries	10,767	8,321	5499	4289	3964	3477	3292	2946
TOTAL	\$13,405	\$10,712	\$7225	\$5636	\$5183	\$4578	\$4257	\$3803

Note: No data for 1978, 1980, and 1982. na = not available. Sources: National Science Foundation and C&EN estimates based on NSF data

DEVELOPMENT IN INDUSTRY: Accounted for half of R&D spending by chemical firms in 1983

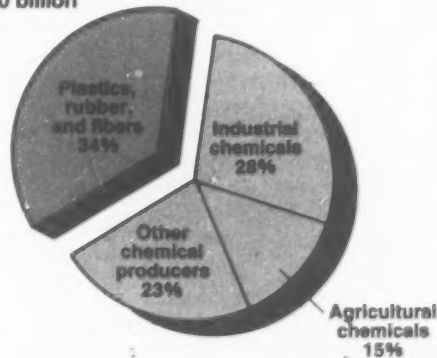
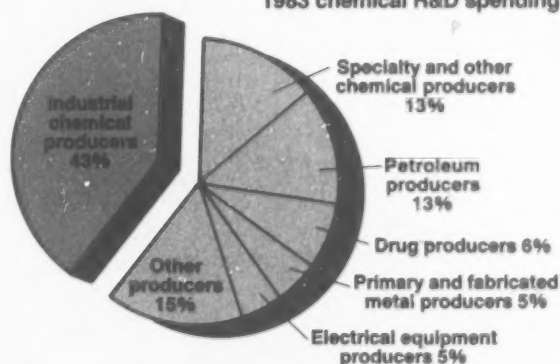
\$ Millions	1983	1981	1979	1977	1976	1975	1974	1973
Chemicals and allied products	\$ 3,999	\$ 2,665	\$ 1,946	\$ 1,518	\$ 1,466	\$ 1,330	\$ 1,191	\$ 1,018
Industrial chemicals	1,687	1,191	920	790	763	700	604	521
Drugs	na	1,000	682	508	493	444	390	325
Other chemicals	na	475	344	219	209	184	197	172
Other industries	43,308	36,819	27,897	21,760	19,511	17,550	16,730	15,790
TOTAL	\$47,307	\$39,484	\$29,843	\$23,278	\$20,977	\$18,879	\$17,921	\$16,808

Note: No data for 1978, 1980, and 1982. na = not available. Sources: National Science Foundation and C&EN estimates based on NSF data

More than 40% of chemical R&D is done by industrial chemical producers . . .

. . . and a third of chemical R&D funds spent on polymers

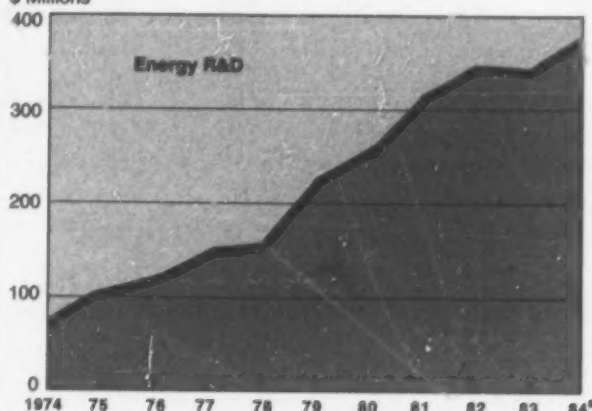
1983 chemical R&D spending^a = \$4.0 billion



^a Excludes basic research on drugs. Source: National Science Foundation

Chemical firms' outlays for energy R&D have risen fivefold since 1974 ...

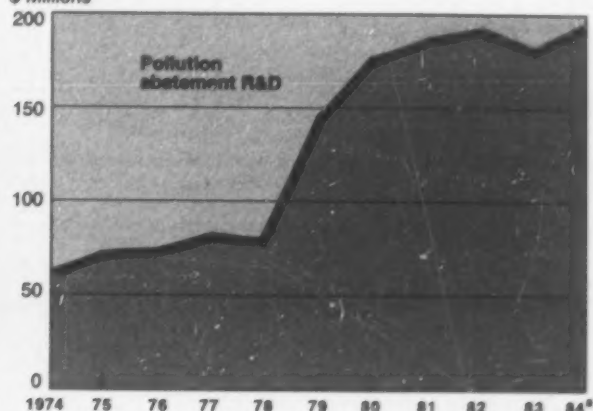
\$ Millions



a NSF estimates. Source: National Science Foundation

... and spending for pollution control has more than tripled

\$ Millions



APPLIED R&D BY ALL INDUSTRY ON CHEMICALS: Drugs capture a bigger share of total

\$ Millions	1983	1981	1979	1977	1976	1975	1974	1973	1972	1971	1970	1969
Industrial chemicals	\$1146	\$1020	na	\$ 822	\$ 728	\$ 665	\$ 589	\$ 489	\$ 451	\$ 457	\$ 442	\$ 417
Plastics, rubber, and fibers	1360	1315	\$ 881	747	674	588	589	511	453	511	521	482
Agricultural chemicals	587	487	292	236	205	176	137	114	108	130	126	104
Other chemicals	940	1081	na	220	246	198	246	229	238	218	223	210
Drugs	2601	1837	1089	959	863	783	683	605	531	535	474	417
TOTAL	\$6634	\$5740	\$3648	\$2984	\$2736	\$2410	\$2246	\$1948	\$1781	\$1851	\$1786	\$1630

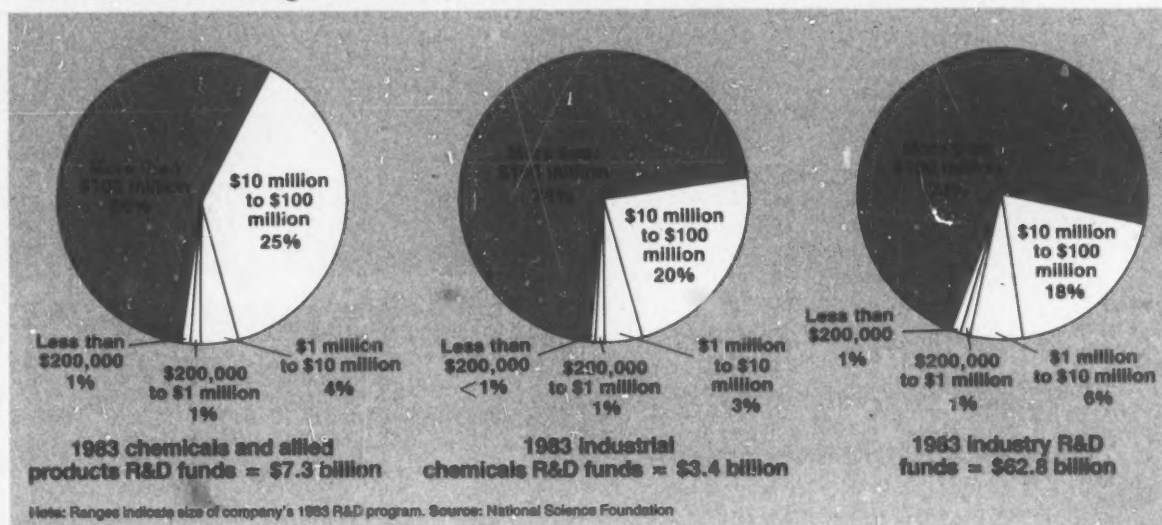
Note: No data for 1976, 1980, and 1982. na = not available. Source: National Science Foundation

APPLIED R&D ON CHEMICALS AND DRUGS: Drug and chemical firms dominate drug research

Industry	Product field (\$ millions)									
	1983		1981		1979		1977		1976	
	Chemicals	Drugs	Chemicals	Drugs	Chemicals	Drugs	Chemicals	Drugs	Chemicals	Drugs
Chemicals and allied products	\$2536	\$2207	\$2402	\$1559	\$1604	\$1020	\$1327	\$903	\$1192	\$817
Industrial chemicals	1746	307	1615	203	1086	136	806	101	711	84
Drugs	250	1817	303	1301	205	840	131	756	130	703
Other chemicals	540	83	484	55	313	42	390	46	351	30
Petroleum refining	531	a	520	0	283	a	192	7	188	4
Rubber products	a	a	a	0	75	0	44	a	31	a
Stone, clay, and glass products	73	a	60	7	37	0	34	0	51	5
Food and kindred products	27	a	45	a	28	a	26	a	25	5
Textiles and apparel	a	0	a	0	a	0	a	0	a	0
Lumber, wood products, and furniture	a	0	15	0	5	0	10	0	8	0
Paper and allied products	31	0	46	0	36	0	22	a	13	a
Primary metals	81	a	79	0	a	0	55	a	47	0
Ferrous metals and products	27	a	23	0	a	0	14	0	13	0
Nonferrous metals and products	54	a	57	0	a	0	41	a	34	0
Fabricated metal products	101	0	79	0	65	a	47	3	42	4
Machinery	a	a	92	0	26	0	24	a	15	a
Electrical equipment	215	4	124	a	62	a	49	4	56	6
Motor vehicles and motor vehicle equipment	126	0	97	0	68	0	48	0	42	0
Other transportation equipment	a	a	22	1	19	0	15	0	a	0
Aircraft and missiles	44	4	52	0	25	0	15	0	27	0
Professional and scientific instruments	36	a	a	a	65	54	43	35	37	30
Other manufacturing industries	21	0	12	0	26	0	12	0	10	0
Nonmanufacturing industries	78	0	77	0	a	a	58	a	62	a
TOTAL	\$4033	\$2601	\$3903	\$1837	\$2559	\$1089	\$2024	\$959	\$1837	\$877

a Not separately available but included in total. Note: No data for 1976, 1980, and 1982. Source: National Science Foundation

Firms with R&D budgets under \$10 million do less than 10% of industrial R&D

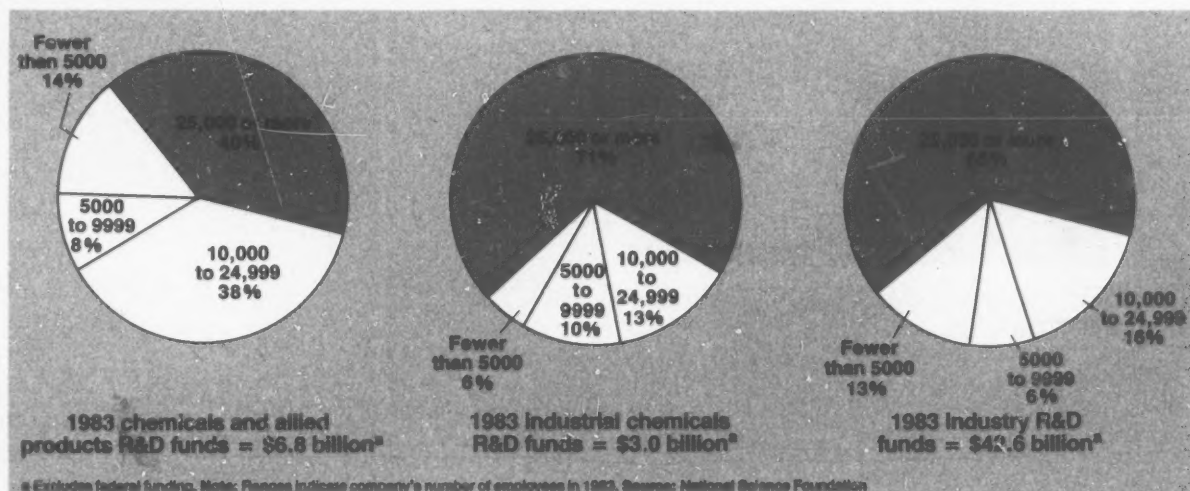


R&D SCIENTISTS AND ENGINEERS IN INDUSTRY: Chemical firms employ 13% of total

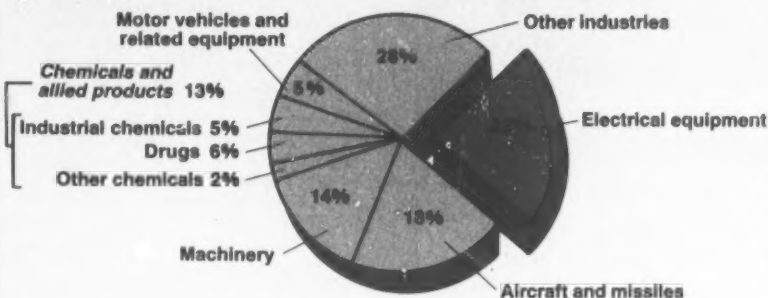
Thousands ^a	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974
Chemicals and allied products	67.5	66.0	61.6	54.7	51.4	50.0	48.3	46.4	44.4	45.2	41.8
Industrial chemicals	26.7	27.2	25.9	21.6	20.9	21.4	21.3	20.6	20.1	21.1	19.1
Drugs	30.3	28.2	25.6	23.3	21.6	20.9	19.5	17.8	16.6	15.6	14.0
Other chemicals	10.5	10.6	10.1	9.8	8.9	7.9	7.5	8.0	7.8	8.5	8.7
Other industries	470.3	456.1	446.2	433.1	399.2	373.9	356.1	336.4	320.0	318.1	318.2
TOTAL	537.8	522.1	509.8	487.8	450.6	423.9	404.4	382.8	364.4	363.3	360.0

^a Full-time equivalent. Note: Data as of January of each year. Source: National Science Foundation

Largest slice of R&D spending is done by firms with 25,000 or more employees



Biggest percentage of industrial R&D scientists and engineers work for electrical equipment firms



1984 total industrial R&D scientists and engineers* = 537,800

* Full-time equivalent. Source: National Science Foundation

R&D SCIENTISTS AND ENGINEERS PER 1000 EMPLOYEES: Up sharply for drug firms

	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971
Chemicals and allied products	53	51	44	42	42	43	42	40	41	40	39	39	41
Industrial chemicals	45	44	37	36	36	38	38	36	38	37	36	34	35
Drugs	82	74	66	60	62	65	62	64	59	57	57	60	65
Other chemicals	37	36	33	30	27	27	29	28	29	30	29	31	31
All industry	35	33	29	27	27	27	27	27	26	25	24	24	26

Source: National Science Foundation

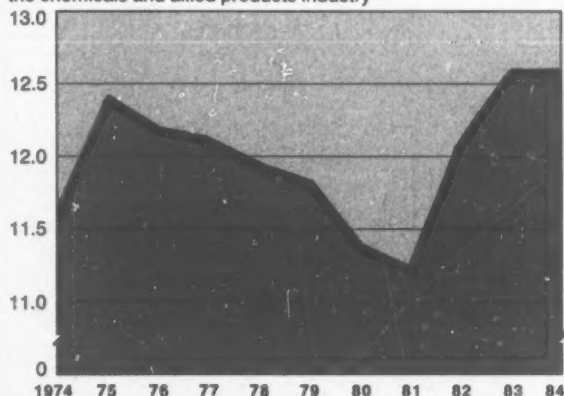
COST PER INDUSTRIAL R&D SCIENTIST OR ENGINEER: Below average for chemical industry

\$ Thousands	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973
Chemicals and allied products	\$109.2	\$104.4	\$ 96.6	\$87.4	\$79.6	\$72.8	\$67.6	\$66.5	\$60.9	\$56.3	\$51.1
Industrial chemicals	126.5	124.3	118.0	103.4	92.8	84.2	79.6	74.7	67.5	63.5	58.6
Drugs	a	a	a	79.2	71.4	64.8	59.9	63.4	60.9	54.3	51.5
Other chemicals	a	a	a	66.5	66.5	61.6	53.8	50.8	43.2	45.3	34.0
All industry	\$118.5	\$112.4	\$103.9	\$94.9	\$87.4	\$80.4	\$75.8	\$72.2	\$66.5	\$63.3	\$59.2

a Not separately available but included in chemicals and allied products. Source: National Science Foundation

Share of R&D scientists and engineers in chemical industry unchanged last year

% of total industrial R&D scientists and engineers in the chemicals and allied products industry^a



a Full-time equivalent, as of January of each year. Source: National Science Foundation

CHEMISTS IN INDUSTRY: Nearly half are employed by chemical and drug companies

Industry	% of industrial chemists			
	All chemists	B.S.	M.S.	Ph.D.
Chemical	33%	27%	28%	40%
Pharmaceutical ^a	16	15	18	16
Petroleum	6	4	6	7
Coatings	6	8	7	4
Food	4	5	5	3
Metals and minerals	3	3	3	2
Rubber	2	3	2	2
Other manufacturing	23	24	23	22
Nonmanufacturing	7	10	8	5

a includes personal-care products. Source: 1985 ACS survey

4 R&D/Universities and colleges

Funding shows biggest gain since 1981

CHARACTER OF UNIVERSITY R&D SPENDING: Basic research got biggest increase last year

\$ Millions	1984 ^a	1983	1982	1981	1980	1979	1978 ^b	1977	1976	1975	1974	Annual change	
												1983-84	1974-84
Basic research	\$5870	\$5214	\$4851	\$4576	\$4026	\$3612	\$3176	\$2800	\$2549	\$2410	\$2154	13%	11%
Applied research	2280	2095	1995	1865	1691	1465	1213	1067	1015	851	736	9	12
Development	475	436	415	377	343	284	236	200	164	148	133	9	14
TOTAL	\$8625	\$7745	\$7261	\$6818	\$6060	\$5361	\$4625	\$4067	\$3729	\$3409	\$3023	11%	11%

^a Estimated. ^b Estimated, based on data from Ph.D.-granting institutions only. Note: Data for institutional fiscal years. Source: National Science Foundation

SOURCE OF UNIVERSITY R&D FUNDS: Federal government provides nearly two thirds

\$ Millions	1984 ^a	1983	1982	1981	1980	1979	1978 ^b	1977	1976	1975	1974	Annual change	
												1983-84	1974-84
Federal government	\$5500	\$4960	\$4749	\$4559	\$4094	\$3595	\$3059	\$2726	\$2512	\$2288	\$2032	11%	10%
Industry	425	370	326	288	235	193	170	139	123	113	96	15	16
Universities	2080	1830	1683	1523	1323	1200	1037	888	810	749	677	14	12
Other sources	620	585	503	448	408	373	359	314	284	259	218	6	11
TOTAL	\$8625	\$7745	\$7261	\$6818	\$6060	\$5361	\$4625	\$4067	\$3729	\$3409	\$3023	11%	11%

^a Estimated. ^b Estimated, based on data from Ph.D.-granting institutions only. Note: Data for institutional fiscal years. Source: National Science Foundation

FIELDS OF UNIVERSITY R&D SPENDING: Physical sciences funding up strongly in 1984

\$ Millions	1984	1983	1982	1981	1980	1979	1978 ^a	1977	1976	1975	1974	Annual change	
												1983-84	1974-84
Physical sciences	\$ 990 ^b	\$ 890.0	\$ 822.1	\$ 766.5	\$ 677.6	\$ 601.9	\$ 496.4	\$ 423.5	\$ 379.4	\$ 350.3	\$ 333.5	11%	11%
Chemistry	375 ^b	335.9	310.7	285.5	244.5	206.4	183.1	159.4	140.1	120.7	115.8	12	12
Physics	455 ^b	407.3	363.3	356.9	322.1	292.0	235.1	201.7	183.1	173.5	169.3	12	11
Engineering	1250 ^b	1100.9	1024.3	960.0	864.0	768.4	601.1	496.5	431.7	380.9	346.9	14	14
Total R&D spending	\$8625	\$7745.0	\$7260.6	\$6818.3	\$6060.1	\$5361.4	\$4624.7	\$4067.0	\$3729.0	\$3408.7	\$3022.6	11	11

^a NSF estimates, based on data from Ph.D.-granting institutions only. ^b C&EN estimates. Note: Data for institutional fiscal years. Source: National Science Foundation

FEDERALLY FINANCED R&D SPENDING AT UNIVERSITIES: Uniform growth in 1985

\$ Millions	1984	1983	1982	1981	1980	1979	1978 ^a	1977	1976	1975	1974	Annual change	
												1983-84	1974-84
Physical sciences	\$ 780 ^b	\$ 699.3	\$ 649.6	\$ 618.6	\$ 554.5	\$ 490.7	\$ 392.3	\$ 338.8	\$ 305.4	\$ 285.0	\$ 270.2	12%	11%
Chemistry	280 ^b	249.0	231.5	216.6	189.3	156.5	138.0	121.5	107.9	92.7	88.7	12	12
Physics	380 ^b	340.7	305.9	308.5	279.7	252.5	199.2	171.9	156.1	149.9	146.5	12	10
Engineering	820 ^b	735.3	697.2	661.6	594.6	526.4	407.5	336.7	290.5	259.4	239.3	12	13
Total R&D spending	\$5500	\$4959.6	\$4749.3	\$4559.0	\$4093.6	\$3595.3	\$3058.7	\$2726.1	\$2511.9	\$2288.1	\$2032.2	11%	10%

^a NSF estimates, based on data from Ph.D.-granting institutions only. ^b C&EN estimates. Note: Data for institutional fiscal years. Source: National Science Foundation

TOP 12 UNIVERSITIES IN R&D SPENDING: MIT, Berkeley at top in chemical outlays

\$ Millions, fiscal 1983	Physical sciences	Chemistry ^a	Engineering	Environmental sciences	Life sciences	Math and computer sciences	Other sciences ^b	Total
Johns Hopkins U	\$57.3 ^c	\$4.6 ^c	\$81.4 ^c	\$31.1 ^c	\$73.6 ^c	\$49.3 ^c	\$10.4 ^c	\$303.1 ^c
Massachusetts Inst. of Technology	56.7	8.9	82.5	11.3	26.5	10.4	13.0	200.3
U of Wisconsin, Madison	15.6	5.3	17.6	13.3	95.1	7.0	19.6	168.3
Stanford U	25.7	6.6	50.2	3.1	38.5	10.6	4.9	163.0
U of Minnesota	10.7	5.0	14.0	3.3	117.5	2.3	8.4	156.2
Cornell U	24.6 ^c	5.7 ^c	23.1 ^c	4.6	89.3 ^c	2.7	9.1 ^c	153.3
U of California, San Diego	17.4	3.9	0.9	78.8	44.1	2.3	3.5	147.0
U of Washington	7.7	2.2	8.2	16.7	79.3	2.4	19.2	133.5
U of Michigan	9.5	2.2	19.8	6.4	62.2	3.0	31.9	132.9
U of California, Berkeley	21.6	7.9	25.2	2.5	50.2	3.0	16.5	119.0
Harvard U	16.4 ^c	6.9 ^c	1.4 ^c	6.2 ^c	85.5 ^c	2.3 ^c	6.8 ^c	118.6 ^c
Columbia U, main division	11.6	4.3	5.9	21.1	65.6	2.5	6.1	113.8

a Included in physical sciences. b Includes social sciences, psychology, and other sciences not listed separately. c Estimated. Source: National Science Foundation

TOP 12 UNIVERSITY R&D CENTERS:^a Some concentrate solely on physical sciences

\$ Millions, fiscal 1983	Physical sciences	Engineering	Environmental sciences	Math and computer sciences	Total ^b
Lawrence Livermore National Lab	\$159.0	\$304.7	\$20.2	\$64.1	\$564.2
Los Alamos National Lab	265.9	168.2	14.6	45.4	544.4
Jet Propulsion Lab	70.5	180.1	33.4	152.0	436.0
Argonne National Lab	63.1	108.6	27.9	3.0	215.2
Lincoln Lab	37.2	136.6	0	19.8	193.7
Brookhaven National Lab	116.7	28.1	9.4	0.6	176.9
Plasma Physics Lab	135.3	0	0	0	135.3
Lawrence Berkeley Lab	77.6 ^c	12.3 ^c	13.2 ^c	4.1 ^c	130.8 ^c
Fermi National Accelerator Lab	130.4	0	0	0	130.4
Stanford Linear Accelerator Center	78.2	0	0	0	78.2
National Center for Atmospheric Research	4.4	0	34.6	0	39.0
Ames Laboratory	11.8	6.4	0.1	0.6	19.0

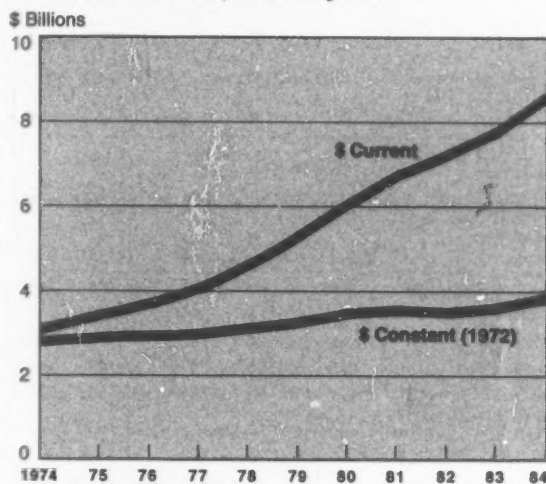
a Data for university-administered federally funded R&D centers. b Includes life sciences and other sciences not listed separately. c Estimated. Source: National Science Foundation

ACADEMIC SCIENTISTS AND ENGINEERS: 6% are chemists or chem engineers

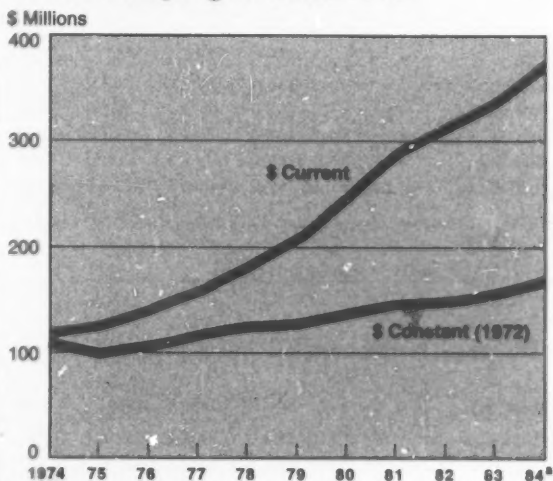
Thousands of scientists and engineers ^a	1984	1983	1982	1981	1980	1978	1977
TOTAL							
Physical scientists	35.5	34.8	34.5	34.1	33.6	32.8	32.1
Chemists	18.8	18.3	18.1	18.1	17.6	17.7	17.1
Physicists	13.6	13.6	13.3	12.9	13.0	12.8	12.5
Engineers	39.0	37.7	36.4	34.9	33.7	31.0	30.1
Chemical	2.5	2.4	2.3	2.3	2.4	2.0	1.9
Other scientists	296.0	285.4	278.2	265.6	255.9	243.9	235.7
TOTAL	370.5	358.9	349.1	334.6	324.2	307.8	297.9
FULL TIME ONLY							
Physical scientists	29.0	28.5	28.6	28.2	28.0	27.9	27.6
Chemists	15.1	14.8	14.7	14.8	14.3	14.7	14.5
Physicists	11.5	11.4	11.4	11.0	11.3	11.3	11.1
Engineers	29.4	28.8	28.0	27.0	26.5	24.7	24.1
Chemical	2.0	2.0	1.9	1.9	1.9	1.7	1.7
Other scientists	223.2	216.8	212.0	204.5	200.5	189.6	184.6
TOTAL	281.6	274.1	268.6	259.7	255.0	242.2	236.3

a In January. Note: Data not available for 1979. Source: National Science Foundation

Spending for academic R&D, in real terms, has risen in most recent years . . .



. . . and spending for R&D in chemistry has been steadily higher since 1975



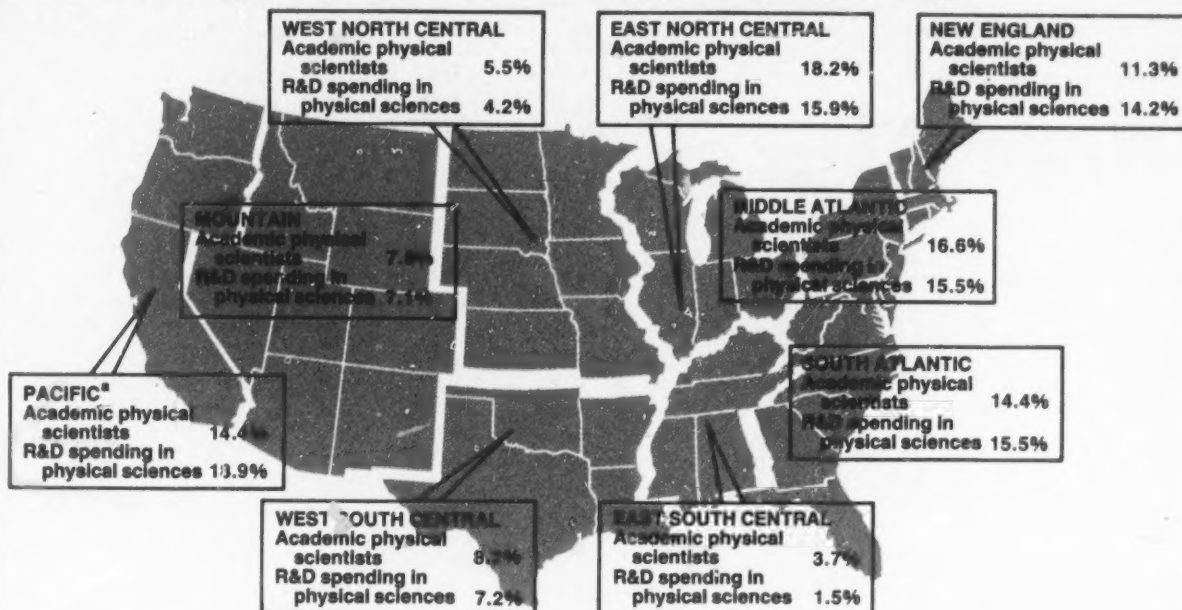
a C&EN estimates. Note: Data for institutional fiscal years. Source: National Science Foundation

SCHOOLS SPENDING MOST ON CHEMICAL R&D: Top 20 spent a third of total in 1983

\$ Thousands	Total spending				Federally financed spending			
	1983	1982	1981	1980	1983	1982	1981	1980
1 Massachusetts Inst. of Technology	\$ 8,914	\$ 9,792	\$ 8,222	\$ 6,764	\$ 8,374	\$ 9,096	\$ 7,572	\$ 6,311
2 U of California, Berkeley	7,945	6,283	6,553	6,022	7,467	5,891	6,008	5,801
3 California Inst. of Technology	6,994	6,136	6,901	6,328	6,554	5,809	6,196 ^a	5,630
4 Harvard U	6,898 ^a	5,512 ^a	6,123 ^a	4,797 ^a	5,224	4,174	4,837	3,631
5 Stanford U	6,589	6,634	5,564	4,788	5,968	5,893	5,337	4,609
6 U of Texas, Austin	5,938	4,843	4,779	3,970	3,527	2,781	3,017	2,564
7 U of Illinois, Urbana	5,886	6,422	5,239	4,261	4,668	4,763	3,847	3,424
8 Cornell U	5,717 ^a	6,239 ^a	4,618	3,808	4,766	5,437	4,062	3,404
9 Indiana U	5,551	5,341	3,637	3,147	4,642	4,237	3,042	2,635
10 U of California, Los Angeles	5,496	5,187	4,420	4,159	5,047	4,978	4,127	4,017
Total, first 10 institutions	65,928	62,389	56,056	48,044	56,237	52,859	47,845	41,826
11 U of Wisconsin, Madison	5,310	4,567	4,122	3,976	3,693	3,404	3,134	2,944
12 U of Massachusetts, Amherst	5,162	4,364	3,230	1,889	3,336	2,773	2,067	1,632
13 U of Minnesota	4,999	4,297	4,260	2,642	3,726	3,377	3,494	2,143
14 U of Pennsylvania	4,982	3,068	3,386	3,688	4,037	2,745	3,073	3,143
15 Texas A&M U	4,963	4,521	4,069	4,097	3,327	2,823	2,793	2,945
16 U of Chicago	4,798 ^a	4,396 ^a	4,139 ^a	3,958 ^a	3,998	3,716	3,719	3,558
17 Pennsylvania State U	4,729	3,564	3,413	2,973	4,236	3,222	2,773	2,527
18 Johns Hopkins U	4,592 ^a	4,721	4,066	4,652	3,604 ^a	3,800	3,881	4,444
19 Purdue U	4,542	4,459	4,600	3,596	3,966	3,946	3,715	3,151
20 U of Maryland, College Park	4,334	4,009	3,109	2,766	2,834	3,068	2,418	2,292
Total, first 20 institutions	114,339	104,355	94,450	82,281	92,994	85,733	78,912	70,605
21 Columbia U, main division	4,281	4,700	3,564	4,437	4,279	4,365	3,471	4,054
22 U of Notre Dame	4,022	4,020	3,855	3,457	3,867	3,866	3,738	3,328
23 U of California, San Diego	3,910	3,894	4,430	4,425 ^a	3,490	3,506	3,933	4,375 ^a
24 Lehigh U	3,664	2,584	1,680	1,066	1,498	1,189	1,063	480
25 U of Utah	3,638	3,364	3,076	2,817	3,085	2,858	2,720	2,373
26 Ohio State U	3,616 ^a	2,907	3,227	2,654	2,786 ^a	2,355	2,679	2,144
27 Princeton U	3,509	3,062	2,513	2,065	2,642	2,485	2,142	1,646
28 U of Nebraska, Lincoln	3,431 ^a	3,217	2,175	2,289	1,995 ^a	1,995	1,757	1,909
29 Northwestern U	3,413	3,026	2,995	2,367	3,012	2,711	2,813	2,221
30 U of Southern California	3,404	2,401	2,345	2,313	2,456	1,717	1,639	1,773
Total, first 30 institutions	151,227	137,530	124,310	110,165	122,104	112,790	104,867	94,906
31 Georgia Inst. of Technology	3,401	3,327	3,660	3,655	2,032	1,800	2,030	2,118
32 U of Oregon, main	3,351	2,971	1,389	1,119	2,686	2,530	1,235	1,035
33 Yale U	3,341	2,875	2,781	2,023	3,008	2,599	2,609 ^a	1,866
34 U of Colorado	3,302	3,492	4,047	3,332	2,695	2,755	3,146	2,605
35 U of Pittsburgh	3,267	2,714	2,039	1,641	2,833	2,188	1,581	1,366
36 U of Rochester	3,167	3,123	2,966	2,089	2,800	2,774	2,553	1,687
37 Arizona State U	3,062	2,323	2,153	1,449	2,124	1,996	1,958	1,365
38 U of Oklahoma	2,890	2,306	1,399	1,275	1,453	1,067	674	617
39 U of South Carolina	2,721	2,483	1,087 ^b	970 ^a	2,221	1,865	902 ^b	816 ^a
40 U of Connecticut	2,720	2,049	1,748	1,300	1,445	1,113	1,022	773
Total, first 40 institutions	182,449	165,193	147,579	129,018	145,401	133,467	122,577	109,156
41 Michigan State U	2,714	2,493	2,178	1,638	1,995	1,832	1,541	1,157
42 Wayne State U	2,645	2,656	2,261	2,163	1,813	1,799	1,636	1,640
43 Rensselaer Polytech Inst.	2,640	2,975	2,286	1,551	1,379	1,724	1,310 ^a	962
44 State U of New York, Stony Brook	2,607	2,783	2,691	1,966	1,809	1,901	2,080	1,632
45 State U of New York, Buffalo	2,589	2,242	2,203	1,665	1,736	1,528	1,626	1,163
46 Florida State U	2,500	2,959	3,012	2,791	1,115	1,124	1,463	1,313
47 Colorado State U	2,478	2,479	2,385	1,973	2,055	2,230	2,079	1,717
48 U of Houston, University Park	2,423	1,816	1,773	1,371	1,117	909	891	599
49 U of North Carolina, Chapel Hill	2,397	2,240	2,016	1,789	2,381	2,218	1,936	1,752
50 U of Florida	2,347	2,248	2,302	2,283 ^a	1,325	1,341	1,156	1,214 ^a
Total, first 50 institutions	\$207,789	\$190,084	\$170,686	\$148,208	\$162,126	\$150,073	\$138,295	\$122,305
NATIONAL TOTAL	\$335,853	\$310,668	\$285,520	\$244,454	\$248,990	\$231,489	\$216,630	\$189,287

a Estimated. b Imputed. Note: Data for institutional fiscal years. Source: National Science Foundation

Schools in Pacific region account for nearly 20% of total academic R&D in physical science, but employ fewer physical scientists than schools in several eastern areas



Key to map: Using the Middle Atlantic states as an example, 16.6% of all physical scientists employed at U.S. Ph.D.-granting universities and colleges are located in this geographical area and 15.5% of all R&D expenditures in the physical sciences by all universities and colleges are made in this area. ^a Includes Alaska, Hawaii, and outlying areas. **Note:** Data are based on 20,127 physical scientists employed at Ph.D.-granting universities and colleges in the U.S. as of January 1984, and R&D expenditures of \$690.0 million in the physical sciences during 1983 fiscal year of all universities and colleges. **Source:** National Science Foundation

CHEMICAL DEGREES: Small declines expected for B.S., M.S. graduates in 1984-85

Academic year	Degrees awarded in chemistry ^a			Degrees awarded in chemical engineering		
	Bachelors	Masters	Ph.D.s	Bachelors	Masters	Ph.D.s
1965-66	9,735	1839	1571	2848	994	354
1966-67	9,872	1831	1744	2869	949	305
1967-68	10,847	2014	1757	3211	1156	367
1968-69	11,807	2070	1941	3557	1136	409
1969-70	11,617	2146	2208	3720	1045	438
1970-71	11,183	2284	2160	3615	1100	406
1971-72	10,721	2259	1971	3663	1154	394
1972-73	10,226	2230	1882	3636	1051	397
1973-74	10,525	2138	1828	3454	1045	400
1974-75	10,649	2006	1824	3142	990	346
1975-76	11,107	1796	1623	3203	1031	308
1976-77	11,322	1775	1571	3581	1086	291
1977-78	11,474	1892	1525	4615	1237	259
1978-79	11,643	1765	1518	5655	1149	304
1979-80	11,446	1733	1551	6383	1271	284
1980-81	11,347	1654	1622	6527	1267	300
1981-82	11,062	1751	1722	6740	1285	311
1982-83 ^b	11,261	1739	1705	7850	1630	390
1983-84 ^b	11,261	1744	1720	7680	1770	410
1984-85 ^b	11,148	1739	1731	7600	1760	410

^a Data do not include biochemistry and geochemistry. ^b ACS estimates. **Source:** Department of Education's National Center for Education Statistics

GRADUATE SCIENCE STUDENTS: Chemists and chem engineers account for 7%

Thousands	1983	1982	1981	1980	1979	1978	1977
TOTAL							
Physical sciences	27.7	26.5	25.8	25.4	24.9	24.7	24.8
Chemistry	16.5	15.8	15.2	15.1	14.9	14.8	14.6
Physics	10.5	10.0	9.9	9.6	9.3	9.2	9.5
Engineering	86.0	78.2	74.1	70.1	67.2	64.3	64.4
Chemical	7.4	6.1	6.3	5.9	5.4	5.2	5.1
Metallurgical and materials	3.3	3.0	3.0	2.8	2.7	2.5	2.5
Petroleum	0.7	0.6	0.5	0.5	0.4	0.4	0.4
Life sciences	91.3	90.7	90.9	90.7	87.5	85.9	83.3
Biochemistry	4.2	4.1	4.0	4.0	3.9	4.0	3.8
Other sciences ^a	153.3	151.4	148.9	147.5	141.0	134.9	134.1
TOTAL	358.3	346.8	340.0	333.7	320.6	309.8	306.6
FULL TIME ONLY							
Physical sciences	24.5	23.3	22.6	22.3	21.8	21.5	21.7
Chemistry	14.5	13.7	13.2	13.1	12.8	12.7	12.6
Physics	9.3	8.9	8.8	8.5	8.3	8.2	8.5
Engineering	53.6	48.7	44.8	41.9	39.3	37.1	36.7
Chemical	5.8	5.5	4.9	4.4	4.2	3.9	3.8
Metallurgical and materials	2.7	2.5	2.4	2.2	2.1	2.0	1.9
Petroleum	0.6	0.5	0.4	0.4	0.3	0.3	0.3
Life sciences	65.2	65.7	67.2	67.7	66.5	65.2	64.3
Biochemistry	4.0	3.8	3.7	3.7	3.6	3.7	3.6
Other sciences ^a	100.3	99.2	99.6	98.6	95.8	92.8	94.8
TOTAL	243.6	236.9	234.2	230.5	223.4	216.6	217.5

^a Includes environmental, mathematical, computer, and social sciences and psychology. **Note:** Data for Ph.D.-granting institutions only. **Source:** National Science Foundation